Electronic Version
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Claims

[c1] 1. A method of fabricating a semiconductor laser device, comprising the steps of:
providing an epitaxial structure;
forming a first mask layer over the epitaxial structure to define a protrudent area of a ridge structure;
forming a conformal second mask layer over the epitaxial structure to cover the first mask layer;
forming a third mask layer over the second mask layer to expose a portion of the second mask layer above the first mask layer;
removing the exposed second mask layer;
removing a portion of the epitaxial structure using the first mask layer and the third mask layer as an etching mask to form the ridge structure;
removing the third mask layer and the remaining second mask layer;
forming an insulating layer over the epitaxial structure;
removing the first mask layer to expose the top surface of the protrudent area; and
forming a conductive layer over the ridge structure, wherein the conductive layer contacts with the top surface of the protrudent area.

[c2] 2. The method of claim 1, wherein the step of removing a portion of the epitaxial structure comprises performing a reactive ion etching operation.

[c3] 3. The method of claim 2, wherein the gaseous etchant used in the reactive ion etching operation comprise argon, method, chlorine and helium ($Ar/CH_4/Cl_2/He$).

[c4] 4. The method of claim 1, wherein the material constituting the insulating layer comprises silicon oxide.

[c5] 5. The method of claim 1, wherein the step of removing the first mask layer comprises etching the epitaxial structure with a boiling mixture of nitric acid and hydrochloric acid solution.

[c6] 6. The method of claim 1, wherein the material constituting the first mask layer, the second mask layer and the third mask layer is selected from a group consisting of silicon nitride, silicon oxide, metal, single photoresist layer, multi-layered structure and various combinations of the above.

[c7] 7. The method of claim 1, wherein the material constituting the conductive layer comprises P-type nickel/gold.

[c8] 8. A method of fabricating a semiconductor laser device,

comprising the steps of:

providing an epitaxial structure having an N-type electrode area and a P-type electrode area;

forming a first mask layer over the epitaxial structure to define a protrudent area of a ridge structure within the P-type electrode area and an N-type ohmic contact metal area within the N-type electrode area;

forming a conformal second mask layer over the epitaxial structure to cover the first mask layer;

forming a third mask layer over the second mask layer to expose a portion of the second mask layer above the first mask layer within the P-type electrode area;

removing the exposed second mask layer;

removing a portion of the epitaxial structure using the first mask layer and the third mask layer within the P-type electrode area as an etching mask to form the ridge structure inside the P-type electrode area;

removing the third mask layer and the remaining second mask layer;

forming an insulating layer over the epitaxial structure to cover the ridge structure within the P-type electrode area and the N-type ohmic contact metal area within the N-type electrode area;

removing the first mask layer to expose the top surface of the protrudent area of the ridge structure within the P-type electrode area and the N-type ohmic contact

metal area within the N-type electrode area;
forming a first conductive layer over the exposed N-type ohmic contact metal area; and
forming a second conductive layer over the top surface of the protrudent area, wherein the second conductive layer fully contacts the top surface of the protrudent area.

[c9] 9. The method of claim 8, wherein the step of removing a portion of the epitaxial structure comprises performing a reactive ion etching operation.

[c10] 10. The method of claim 8, wherein the gaseous etchant used in the reactive ion etching operation comprise argon, method, chlorine and helium ($Ar/CH_4/Cl_2/He$).

[c11] 11. The method of claim 8, wherein the material constituting the insulating layer comprises silicon oxide.

[c12] 12. The method of claim 8, wherein the step of removing the first mask layer comprises etching the epitaxial structure with a boiling mixture of nitric acid and hydrochloric acid solution.

[c13] 13. The method of claim 8, wherein the material constituting the first mask layer, the second mask layer and the third mask layer is selected from a group consisting of silicon nitride, silicon oxide, metal, single photoresist

layer, multi-layered structure and various combinations of the above.

[c14] 14. The method of claim 8, wherein after forming the second conductive layer over the top surface of the protrudent area, further comprises forming a metallic layer over the epitaxial structure to cover the first conductive layer and the second conductive layer.

[c15] 15. The method of claim 8, wherein the material constituting the mask layer comprises nickel.

[c16] 16. The method of claim 8, wherein the material constituting the first conductive layer comprises N-type titanium/aluminum/titanium/gold.

[c17] 17. The method of claim 8, wherein the material constituting the conductive layer comprises P-type nickel/gold.

[c18] 18. A semiconductor laser device structure, comprising:
a substrate;
a first ohmic contact layer positioned over the substrate;
a first cladding layer positioned over the first ohmic contact layer;
a first waveguide layer positioned over the first cladding layer;
a light-emitting layer positioned over the first waveguide

layer;
a second waveguide layer positioned over the light-emitting layer;
a second cladding layer formed over the second waveguide layer ;
a second ohmic contact layer formed over the second cladding layer, wherein
a ridge structure is formed within the second cladding layer and the second ohmic contact layer, the ridge structure comprising:
two channels that penetrate a certain thickness of the second ohmic contact layer and the second cladding layer; and
a protrudent block positioned between the channels;
an insulating layer formed outside the top surface of the protrudent block above the second ohmic contact layer; and
a conductive layer enclosing the ridge structure and making contact with the top surface of the protrudent block.

[c19] 19. The semiconductor laser device structure of claim 18, wherein the material constituting the insulating layer is selected from a group consisting of silicon, silicon oxide, benzocyclobutene (BCB), single layer polyimide, multi-layered structure and various combinations of the

above.

[c20] 20. The semiconductor laser device structure of claim 18, wherein the protrudent block has a width between about 1μm to 10μm.

[c21] 21. The semiconductor laser device structure of claim 18, wherein the protrudent block has a width between about 1μm to 3μm.

[c22] 22. The semiconductor laser device structure of claim 18, wherein the conductive layer has a width greater than or equal to the protrudent block in the ridge structure.

[c23] 23. The semiconductor laser device structure of claim 18, wherein the material constituting the substrate comprises sapphire or gallium nitride (GaN).

[c24] 24. The semiconductor laser device structure of claim 18, wherein the substrate is fabricated using a semiconductor compound having a multiple of group III-V elements.

[c25] 25. The semiconductor laser device structure of claim 18, wherein the group III element in the semiconductor compound having group III-V elements comprises aluminum, indium, gallium and boron.

[c26] 26. The semiconductor laser device structure of claim 18, wherein the group V element in the semiconductor compound having group III-V elements comprises nitrogen, phosphorus, arsenic and antimony.

[c27] 27. The semiconductor laser device structure of claim 18, wherein the light-emitting layer comprises a multiple quantum well (MQW).

[c28] 28. The semiconductor laser device structure of claim 18, wherein the material constituting the second ohmic contact layer comprises P-type gallium nitride.

[c29] 29. The semiconductor laser device structure of claim 18, wherein the material constituting the first ohmic contact layer comprises N-type gallium nitride.

[c30] 30. The semiconductor laser device structure of claim 18, wherein the material constituting the conductive layer comprises P-type nickel/gold.